

CLAIMS

What is claimed is:

- 1 1. A method for symbol synchronization comprising:
 - 2 performing a windowing function on a received signal
 - 3 to produce a symbol sample;
 - 4 multiplying the symbol sample and a reference
 - 5 synchronization symbol in the frequency domain to produce
 - 6 a first signal;
 - 7 determining the sign of the first signal to produce a
 - 8 second signal; and
 - 9 performing a Fourier transform on the second signal
 - 10 to produce a third signal containing time-shift
 - 11 information to align the received signal.
- 1 2. The method of claim 1 wherein the length of the
- 2 symbol sample is equal to the length of the reference
- 3 synchronization symbol.
- 1 3. The method of claim 1 wherein the windowing function
- 2 is accomplished by a Hanning windowing function.
- 1 4. The method of claim 1 further comprising:
 - 2 performing a Fourier transform on the symbol sample
 - 3 to transform the symbol sample from the time domain to the
 - 4 frequency domain before it is multiplied with the
 - 5 reference synchronization symbol.
- 1 5. The method of claim 1 wherein the first signal
- 2 comprises real and imaginary frequency components.
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1 6. The method of claim 5 wherein determining the sign of
2 the first signal comprises determining the signs of both
3 the real and imaginary frequency components of the first
4 signal to produce two corresponding signal components
5 which comprise a fourth signal.

1 7. The method of claim 6 wherein the two components of
2 the fourth signal are convolved to produce the second
3 signal.

1 8. The method of claim 1 wherein the Fourier transform
2 performed on the second signal is a fast Fourier
3 transform.

1 9. The method of claim 1 wherein the third signal
2 comprises real and imaginary components.

1 10. The method of claim 9 further comprising:
2 adding the real and imaginary components of the third
3 signal together to produce a fifth signal.

1 11. The method of claim 10 further comprising:
2 aligning the received signal according to the time-
3 shift indicated by the fifth signal.

1 12. The method of claim 10 further comprising:
2 detecting the peak of the fifth signal to determine
3 the time-shift required to align the received signal.

1 13. The method of claim 12 further comprising:

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2 generating an index based on the location of the
3 detected peak, the index corresponding to the amount by
4 which to time-shift the received signal to synchronize it.

1 14. The method of claim 12 wherein the magnitude of the
2 peak indicates the direction of the time-shift required to
3 align the received signal.

1 15. A machine-readable medium having one or more
2 instructions for synchronizing a received signal, which
3 when executed by a processor, causes the processor to
4 perform operations comprising:

5 performing a windowing function on the received
6 signal to produce a symbol sample;

7 multiplying the symbol sample and a reference
8 synchronization symbol in the frequency domain to produce
9 a first signal;

10 determining the sign of the first signal to produce a
11 second signal; and

12 performing a Fourier transform on the second signal
13 to produce a third signal containing time-shift
14 information to align the received signal.

1 16. The machine-readable medium of claim 15 wherein the
2 length of the symbol sample is equal to the length of the
3 reference synchronization symbol.

1 17. The machine-readable medium of claim 15 wherein the
2 windowing is accomplished by a Hanning windowing function.

1 18. The machine-readable medium of claim 15 further
2 comprising:

3 performing a Fourier transform on the symbol sample
4 to transform the symbol sample from the time domain to the
5 frequency domain before it is multiplied with the
6 reference synchronization symbol.

1 19. The machine-readable medium of claim 15 wherein the
2 first signal comprises real and imaginary frequency
3 components.

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1 20. The machine-readable medium of claim 19 wherein
2 determining the sign of the first signal comprises
3 determining the signs of both the real and imaginary
4 frequency components of the first signal to produce two
5 corresponding components which comprise a fourth signal.

1 21. The machine-readable medium of claim 20 wherein the
2 two components of the fourth signal are convolved to
3 produce the second signal.

1 22. The machine-readable medium of claim 15 wherein the
2 Fourier transform performed on the second signal is a fast
3 Fourier transform.

1 23. The machine-readable medium of claim 15 wherein the
2 third signal comprises real and imaginary components.

1 24. The machine-readable medium of claim 23 further
2 comprising:

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3 adding the real and imaginary components of the third
4 signal together to produce a fifth signal.

1 25. The machine-readable medium of claim 24 further
2 comprising:

3 aligning the received signal according to the time-
4 shift indicated by the fifth signal.

1 26. The machine-readable medium of claim 25 further
2 comprising:

3 detecting the peak of the fifth signal to determine
4 the time-shift required to align the received signal.

1 27. The machine-readable medium of claim 26 further
2 comprising:

3 generating an index based on the location of the
4 detected peak, the index corresponding to the amount by
5 which to time-shift the received signal to synchronize it.

1 28. The machine-readable medium of claim 26 wherein the
2 magnitude of the peak indicates the direction of the time-
3 shift required to align the received signal.

1 29. A device for aligning a received signal comprising:
2 a windowing module to perform a windowing function on
3 the received signal to produce a symbol sample therefrom;
4 a multiply module communicatively coupled to the
5 windowing module to receive the symbol sample and multiply
6 the symbol sample to a reference synchronization symbol in
7 the frequency domain to produce a first signal therefrom;

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8 a sign detector module communicatively coupled to the
9 multiply module to receive the first signal, determine the
10 sign of the first signal, and produce a second signal
11 therefrom; and

12 a Fourier transform module communicatively coupled to
13 the sign detector module to receive the second signal,
14 perform a Fourier transform on the second signal, and
15 produce a third signal therefrom containing time-shift
16 information to align the received signal.

1 30. The device of claim 29 wherein the length of the
2 symbol sample is equal to the length of the reference
3 synchronization symbol.

1 31. The device of claim 30 wherein the windowing module
2 is capable of performing a Hanning windowing function.

1 32. The device of claim 29 wherein the first signal
2 produced by the multiply module has real and imaginary
3 components.

1 33. The device of claim 32 wherein the sign detector
2 module determines the sign of the real and imaginary
3 components of the first signal, and produces two
4 corresponding signal components which comprise a fourth
5 signal.

1 34. The device of claim 33 further comprising:
2 a convolution module communicatively coupled to the
3 sign detector module to receive the fourth signal

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4 components and convolved them to produce the second
5 signal.

1 35. The device of claim 29 wherein the Fourier transform
2 module is capable of performing fast Fourier transforms.

1 36. The device of claim 29 further comprising:
2 a second Fourier transform module communicatively
3 coupled to receive the second signal from the sign
4 extractor module, perform a Fourier transform on the
5 symbol sample to transform the symbol sample from the time
6 domain to the frequency domain before it is multiplied to
7 the reference synchronization symbol.

1 37. The device of claim 36 wherein the third signal
2 produced by the second Fourier transform module comprises
3 real and imaginary components.

1 38. The device of claim 37 further comprising:
2 an adding component communicatively coupled to the
3 second Fourier transform module to receive the third
4 signal, add the real and imaginary components of the third
5 signal and produce a fifth signal.

1 39. The device of claim 38 further comprising:
2 a peak detector to detect the peak of the fifth
3 signal and determine the time-shift required to align the
4 received signal.

1 40. The device of claim 39 further comprising:

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2 a controller communicatively coupled to the peak
3 detector to received the received signal according to the
4 time-shift indicated by the fifth signal.

1 41. A system for aligning a received signal comprising:
2 means for windowing the received signal to produce a
3 symbol sample;
4 means for multiplying the symbol sample and a
5 reference synchronization symbol in the frequency domain
6 to produce a first signal;
7 means for determining the sign of the first signal to
8 produce a second signal; and
9 means for performing a Fourier transform on the
10 second signal to produce a third signal containing time-
11 shift information to align the received signal.

1 42. The system of claim 41 wherein the length of the
2 symbol sample is equal to the length of the reference
3 synchronization symbol.

1 43. The system of claim 42 wherein the windowing is
2 accomplished by a Hanning windowing function.

1 44. The system of claim 41 further comprising:
2 means for performing a Fourier transform on the
3 symbol sample to transform the symbol sample from the time
4 domain to the frequency domain before it is multiplied
5 with the reference synchronization symbol.

1 45. The system of claim 41 further comprising:

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2 means for detecting the peak of the third signal to
3 determine the time-shift required to align the received
4 signal.

1 46. The system of claim 41 further comprising:
2 means for aligning the received signal according to
3 the time-shift indicated by the third signal.